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Swift Burst Alert Telescope (BAT) Temperature Controller Thermal Test Procedure

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Code 565



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BAT Temperature Controller Thermal Test Procedure

Original

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This document defines the thermal tests performed for the Swift Burst Alert Telescope (BAT) Detector Array, Loop Heat Pipe, S/C, and OB Temperature Controller. It is an internal quality control record that is controlled by the Product Design Lead (PDL) for the Electrical System. Proposed changes to this document must be submitted to the PDL along with supportive material justifying the proposed change. Comments or questions concerning this document and proposed changes shall be addressed to:

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1 INTRODUCTION

The BAT Detector Module temperature controller is a crucial component of the Burst Alert Telescope (BAT) thermal control system. It is necessary to meet the temperature gradient and temperature stability requirements of the detector modules. A temperature controller was developed at GSFC for this purpose. It contains eight separate control channels so that it provides temperature control for four primary heater circuits and four secondary. All four circuits per side are controlled to the same temperature set-point. Each circuit can control heater power up to 5 W. An adjustable voltage signal in the 0 V to 5 V range can be sent to the temperature controller to change the temperature set point through a range of -15°C to $+25^{\circ}\text{C}$. Each of the sixteen flight Detector Module Blocks have a temperature controller. Each of the two loop heat pipe compensation chambers will also have a temperature controller. Qualification testing of the temperature controller is required prior to the fabrication of the flight units.

1.1 Definitions

For the purposes of this document, the following definitions are valid:

Component:	An electrical or electronic element which is part (or all) of the instrument subsystem, i.e., DM, BCDH, BVR, etc.
ICD:	Interface Control Document. This document specifies the information necessary to connect the subject subsystem or component to other components.
Subsystem:	Any component, group of components, box, or structure on the instrument, which is intended to perform a given function. For example: the Power subsystem is comprised of several components, which together perform the function of providing power to the instrument.
Instrument:	The entire assembly of the Array, the Power Box, and Image Processor
Observatory:	The entire payload of the launch vehicle, which is intended to operate as a system in orbit. This includes the instruments.

1.2 Abbreviations And Acronyms

BAT	Burst Alert Telescope
GSE	Ground Support Equipment
ICD	Interface Control Drawing (or Document)
mW	Milli-watt
MAR	Mission Assurance Requirements (Document)
OB	Optical Bench
S/C	Spacecraft

2 APPLICABLE SPECIFICATIONS/ REQUIREMENTS

2.1 References

NASA-STD-8739	NASA Workmanship Standards
PPL-21	NASA GSFC Preferred Parts List (derating)
GSFC-Swift-Spec-002	Swift Mission Assurance Requirements
410.4-MGMT-005	BAT TCS Requirements
410.4-RQMT-0001	BAT Mechanical Requirements
410-PG-8730.3.1	Swift Quality Management Plan
410.4-PLAN-0011	BAT Contamination Plan
410.4-PLAN-0006	Swift BAT Parts Control Plan
BAT-ELEC-001	Swift Burst Alert Telescope (BAT) Electrical Specification
410.4-SPEC-0014	Swift Burst Alert Telescope (BAT) Temperature Controller Specification
410-4-ICD-0008	BAT Temperature Controller Interface Control Document
410.4-SPEC-0015	Swift Burst Alert Telescope (BAT) Temperature Controller Inverter Specification
410-4-ICD-0010	BAT Temperature Controller Inverter Interface Control Document

3 TEST ITEMS

1. Thermal Vacuum chamber < 1.0x10⁻⁰⁵ torr with shroud temperature control, or a thermal chamber
2. Temperature controller
3. Controller connector box
4. 8 sets of approximately 2KOhm test heaters
5. Power Supplies, 1-28 Volt DC, 2- 5Volt DC, 1-15 Volt DC
6. Mounting Plate for mounting 8 DM frame simulators in chamber
7. Aluminum and Kapton Tape
8. [8 thermistors](#) and data logging/monitoring system
9. Swift BAT Temperature Controller GSE Laptop
10. Swift BAT Heater Vset Box
11. National Instruments SCB-68 DAC

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4 TEST OBJECTIVES

The temperature controller thermal test is being performed to accomplish the following objectives:

- To demonstrate that the temperature set point of the temperature controller can be adjusted through a range of temperatures from -15°C to $+25^{\circ}\text{C}$ by sending a voltage signal in the 0 V to 5 V range from the Power Converter Box simulator to the controller. (Section 6.1 Temperature Range Procedure) or to demonstrate that the fixed temperature set point of the temperature controller remains at the fixed temperature set point. (Section 6.2 Fixed Temperature Set Point Procedure)
- To demonstrate that the eight control circuits of the temperature controller are electrically well isolated such that cross talk between the eight heater circuits is not a problem when operating them simultaneously.
- To demonstrate that all eight control channels of the temperature controller has an accuracy of $\pm 0.25^{\circ}\text{C}$ or better.

5 TEST DESCRIPTION

The temperature controller is mounted on an aluminum plate. A Power Converter Box simulator is connected to the temperature controller to supply an adjustable voltage signal for changing heater set point temperatures. The Power Converter Box is located outside the chamber, and is connected to the temperature controller through the chamber feedthrough. Eight kapton film heater circuits, ~~Sixteen~~, YSI 44910 precision thermistors, are attached to the DM simulators. The DM frame simulators are isolated from their mounting plate. The thermistors and heaters are connected to the temperature controller.

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Figure 1 illustrates the basic test set-up. Two of the DM simulators have a 2000 Ohm heater each and the remaining six has (3) 600 Ohm heaters wired in series. The control thermistors are located directly behind the heaters on the opposite side of the DM simulator plate. Each plate has ~~1~~, monitoring thermistor, adjacent to the control thermistor.

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6 TEST PROCEDURE

6.1 Temperature Range Procedure

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- Evacuate test chamber to a pressure of $<1.0\text{e-}05$ torr.(Disregard if using thermal chamber)
- Set chamber to 22°C.
- Set temperature controller power supply voltage to 35V.
- Set temperature controller voltage to 0.738 V and allow DM frame simulators to stabilize at 25°C.
- Set temperature controller power supply voltage to 24V and allow DM frame simulators to stabilize at 25°C.
- Set temperature controller voltage, power supply voltage and chamber temperature according to steps A thru J Table 1 below. Allow temperature stabilization at each step.
- Using GSE archive data to different files for each temperature set point.

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Table 1: Test Set-Points

Step #	Power Supply Voltage (V)	Chamber Temp. (°C)	Controller Signal (V)	Controller Set-Point (°C)
A	35	22	0.738	25
B	24	22	0.738	25
C	35	12	1.723	15
D	24	12	1.723	15
E	35	2	2.807	5
F	24	2	2.807	5
G	35	-8	3.882	-5
H	24	-8	3.882	-5
I	35	-18	4.829	-15
J	24	-18	4.829	-15

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- Once stabilization has occurred at the final setting, reset the chamber temperature to 25°C.
- Set the Power Converter Box simulator voltage to 28V
- Set temperature controller voltage to 0.738 V (25°C).
- When all the thermocouples and chamber are 25°C±2°C, turn off all heater power supplies.
- Turn off data recorder
- Turn off chamber controller and vent the chamber back to ambient pressure. (Disregard if using thermal chamber)
- Open the chamber door. The thermocouples are removed from the test item, and finally the test items are removed from the chamber.

6.2 Fixed Temperature Set Point Procedure

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- Evacuate test chamber to a pressure of <1.0e-05 torr.(Disregard if using thermal chamber)
- Set chamber to 2 to 3 degrees °C colder than the fixed temperature set point of the temperature controller under test.
- Set temperature controller power supply voltage to 35V.

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- Allow DM frame simulators to stabilize at the fixed temperature set point of the temperature controller under test.
- Set temperature controller power supply voltage to 24V
- Allow DM frame simulators to stabilize at the fixed temperature set point of the temperature controller under test.
- Once stabilization has occurred at the final setting, reset the chamber temperature to 25°C.
- Set the Power Converter Box simulator voltage to 28V
- When all the thermocouples and chamber are 25°C±2°C, turn off all heater power supplies.
- Turn off data recorder
- Turn off chamber controller and vent the chamber back to ambient pressure. (Disregard if using thermal chamber)
- Open the chamber door. The thermocouples are removed from the test item, and finally the test items are removed from the chamber.

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7 QUALITY ASSURANCE

Design, fabrication, assembly, and test shall be in accordance with the Swift Mission Assurance Requirements Document, 410.4-SPEC-0001 (Also referenced as: GSFC-SWIFT-410-SPEC-0002) and the Swift Quality Management Plan, 410.4-PG-8730.3.1. The Swift BAT Parts Control Plan 410.4-PLAN-0006 will be implemented. All personnel working within 3 feet of hardware must be ESD certified and follow requirements of NASA-STD-8739.7.